

WHAT IS CLAIMED IS:

1. An ink jet head, comprising a plurality of line heads arranged in a scanning direction, wherein:

each line head includes:

5 a pressure chamber block including a common liquid chamber for storing an ink, a plurality of pressure chambers communicated to the common liquid chamber, and a plurality of nozzles respectively communicated to the pressure chambers; and

10 a plurality of actuator blocks each including a piezoelectric element, a first electrode and a second electrode for applying a voltage across the piezoelectric element, and a vibration plate, the plurality of actuator blocks being arranged on one surface of the pressure chamber block so that more than one of the pressure chambers of the pressure chamber block are covered by the vibration plate; and

15 the actuator blocks of each line head are arranged in a head longitudinal direction with adjacent ones of the actuator blocks being spaced apart from each other, and the actuator blocks of the line head are shifted from the actuator blocks of another line head in the head longitudinal direction while partially overlapping with the actuator blocks of the other line head in the head longitudinal direction.

2. The ink jet head of claim 1, wherein:

the line heads include a plurality of line heads of a same shape; and

20 the line heads of the same shape are shifted from one another in the head longitudinal direction.

3. The ink jet head of claim 2, wherein:

25 in each of the line heads of the same shape, a plurality of actuator blocks are arranged at a predetermined interval that is shorter than a length of each actuator block in the head longitudinal direction; and

the line heads of the same shape are shifted from each other in the head

longitudinal direction so that the actuator block of one line head is located between the actuator blocks of the other line head with respect to the head longitudinal direction.

4. The ink jet head of claim 1, wherein:

the line heads include at least a pair of line heads of a same shape; and
the pair of line heads are arranged in point symmetry with each other.

5. The ink jet head of claim 4, wherein:

in each of the line heads of the same shape, a plurality of actuator blocks are arranged at a predetermined interval that is shorter than a length of each actuator block in the head longitudinal direction; and

the line heads of the same shape are arranged in point symmetry with each other so that the line heads are aligned with each other at both ends in the head longitudinal direction and so that the actuator block of one line head is located between the actuator blocks of the other line heads with respect to the head longitudinal direction.

6. The ink jet head of claim 3, wherein the actuator blocks of the plurality of line heads as a whole are arranged in a staggered pattern.

7. The ink jet head of claim 5, wherein the actuator blocks of the plurality of line heads as a whole are arranged in a staggered pattern.

8. The ink jet head of claim 1, wherein the line heads discharge an ink of a same type.

9. The ink jet head of claim 1, wherein:

the line heads form line head groups each including a plurality of line heads that discharge an ink of a same type;

a plurality of such line head groups are provided in the scanning direction so as to discharge inks of different types.

10. The ink jet head of claim 1, wherein the line heads discharge inks of different types.

11. An ink jet head, comprising:

a pressure chamber block including a common liquid chamber for storing an ink, a plurality of pressure chambers communicated to the common liquid chamber, and a plurality of nozzles respectively communicated to the pressure chambers; and

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a plurality of actuator blocks each including a piezoelectric element, a first electrode and a second electrode for applying a voltage across the piezoelectric element, and a vibration plate, the plurality of actuator blocks being arranged on one surface of the pressure chamber block so that more than one of the pressure chambers of the pressure chamber block are covered by the vibration plate, wherein:

the pressure chambers of the pressure chamber block form a plurality of pressure chamber rows arranged in a head longitudinal direction, each pressure chamber row including more than one of the pressure chambers that are arranged in a direction inclined from the head longitudinal direction;

the pressure chamber rows are arranged parallel to one another;

each of the actuator blocks is formed in a parallelogram shape having a side that is parallel to a row direction of each pressure chamber row; and

the actuator blocks are arranged in the head longitudinal direction so as to be spaced apart from one another.

12. The ink jet head of claim 11, wherein:

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the pressure chambers of the pressure chamber block are arranged at a predetermined interval with respect to the head longitudinal direction so that a longitudinal direction of each pressure chamber is perpendicular to the head longitudinal direction;

the pressure chambers of each pressure chamber row are arranged at the predetermined interval; and

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the pressure chamber at one end of a pressure chamber row and the pressure chamber at one end of an adjacent pressure chamber row are arranged at the predetermined

interval.

13. The ink jet head of claim 11, wherein:

the pressure chambers of the pressure chamber block are arranged at a predetermined interval with respect to the head longitudinal direction so that a longitudinal direction of each pressure chamber is perpendicular to the head longitudinal direction;

at least two pressure chambers included in each pressure chamber row are arranged at an interval that is a multiple of the predetermined interval; and

at least one of the pressure chambers included in each pressure chamber row is provided between two pressure chambers included in an adjacent pressure chamber row with respect to the head longitudinal direction.

14. The ink jet head of claim 11, wherein:

the pressure chambers of the pressure chamber block are arranged at a predetermined interval with respect to the head longitudinal direction so that a longitudinal direction of each pressure chamber is inclined from the head longitudinal direction;

the pressure chambers of each pressure chamber row are arranged at the predetermined interval; and

the pressure chamber at one end of a pressure chamber row and the pressure chamber at one end of an adjacent pressure chamber row are arranged at the predetermined interval.

15. The ink jet head of claim 11, wherein:

the pressure chambers of the pressure chamber block are arranged at a predetermined interval with respect to the head longitudinal direction so that a longitudinal direction of each pressure chamber and a row direction of each pressure chamber row are parallel to each other;

at least two pressure chambers included in each pressure chamber row are arranged at an interval that is a multiple of the predetermined interval; and

at least one of the pressure chambers included in each pressure chamber row is provided between two pressure chambers included in an adjacent pressure chamber row with respect to the head longitudinal direction.

16. The ink jet head of claim 11, wherein:

5 the pressure chamber block includes a plurality of sets of the common liquid chamber, the nozzles, the pressure chamber rows and the actuator blocks, the plurality of sets being arranged in a scanning direction.

10 17. The ink jet head of claim 11, wherein the actuator block includes a conductive vibration plate that functions also as the second electrode, instead of including the second electrode and the vibration plate.

18. An ink jet head, comprising:

15 a head body including two or more nozzle rows each including a plurality of nozzles, wherein one or more of the nozzles of at least one nozzle row is located along a same line in a scanning direction with one or more of the nozzles of another nozzle row; and

an actuator for causing an ink to be discharged from the nozzles,

wherein the actuator causes an ink of a same type to be discharged, alternately by one shot or by a number of shots, from the nozzles that are located along the same line in the scanning direction.

20 19. An ink jet head, comprising at least two head blocks arranged in a scanning direction, each head block including a head body in which one or more nozzle row including a plurality of nozzles is formed, and an actuator for causing an ink to be discharged from the nozzles, wherein:

25 the head blocks are arranged so that one or more of the nozzles of at least one head block is located along a same line in a scanning direction with one or more of the nozzles of another head block; and

the actuators of the head blocks cause an ink of a same type to be discharged, alternately by one shot or by a number of shots, from the nozzles that are located along the same line in the scanning direction.

20. An ink jet head, comprising:

5 a pressure chamber block including a common liquid chamber for storing an ink, a plurality of pressure chambers communicated to the common liquid chamber, and a plurality of nozzles respectively communicated to the pressure chambers; and

10 an actuator including a piezoelectric element, a first electrode and a second electrode for applying a voltage across the piezoelectric element, and a vibration plate, the actuator being arranged on the pressure chamber block so that the pressure chambers of the pressure chamber block are covered by the vibration plate, wherein:

15 the pressure chambers of the pressure chamber block form a plurality of pressure chamber rows arranged in a head longitudinal direction and in a scanning direction, each pressure chamber row including more than one of the pressure chambers arranged in a direction that is inclined from the head longitudinal direction;

20 at least one pressure chamber of a pressure chamber row is located along a same line in the scanning direction with at least one pressure chamber of another pressure chamber row, and nozzles that correspond to the pressure chambers located along the same line in the scanning direction are also located along a same line in the scanning direction; and

the actuator causes an ink of a same type to be discharged, alternately by one shot or by a number of shots, from the nozzles that are located along the same line in the scanning direction.

21. The ink jet head of claim 20, wherein:

25 the actuator includes a plurality of actuator blocks each having an area that is smaller than the pressure chamber block;

the actuator blocks are arranged in the head longitudinal direction and in the scanning direction; and

adjacent ones of the actuator blocks are spaced apart from each other in the scanning direction while partially overlapping with each other with respect to the head longitudinal direction.

22. An ink jet head, comprising:

a pressure chamber block including a common liquid chamber for storing an ink, a plurality of pressure chambers communicated to the common liquid chamber, and a plurality of nozzles respectively communicated to the pressure chambers; and

an actuator including a piezoelectric element, a first electrode and a second electrode for applying a voltage across the piezoelectric element, and a vibration plate, the actuator being arranged on the pressure chamber block so that the pressure chambers of the pressure chamber block are covered by the vibration plate, wherein:

the pressure chambers of the pressure chamber block form a plurality of pressure chamber rows arranged in a head longitudinal direction, each pressure chamber row including more than one of the pressure chambers arranged in a direction that is inclined from the head longitudinal direction;

at least one pressure chamber of a pressure chamber row is located along a same line in the scanning direction with at least one pressure chamber of another pressure chamber row, and nozzles that correspond to the pressure chambers located along the same line in the scanning direction are also located along a same line in the scanning direction; and

the actuator causes an ink of a same type to be discharged, alternately by one shot or by a number of shots, from the nozzles that are located along the same line in the scanning direction.

23. The ink jet head of claim 22, wherein:

the actuator includes a plurality of actuator blocks each in a parallelogram shape having an area that is smaller than the pressure chamber block and having a side that is parallel to a row direction of the pressure chamber rows;

the actuator blocks are arranged in the head longitudinal direction; and

adjacent ones of the actuator blocks are spaced apart from each other.

24. An ink jet head, comprising a plurality of line heads arranged in a scanning direction, wherein:

each line head includes:

a pressure chamber block including a common liquid chamber for storing an ink, a plurality of pressure chambers communicated to the common liquid chamber, and a plurality of nozzles respectively communicated to the pressure chambers; and

an actuator including a piezoelectric element, a first electrode and a second electrode for applying a voltage across the piezoelectric element, and a vibration plate, the actuator being arranged on the pressure chamber block so that the pressure chambers of the pressure chamber block are covered by the vibration plate,

wherein the pressure chambers of the pressure chamber block form a plurality of pressure chamber rows arranged in a head longitudinal direction, each pressure chamber row including more than one of the pressure chambers arranged in a direction that is inclined from the head longitudinal direction;

the line heads are arranged so that one or more pressure chamber of at least one line head is located along a same line in the scanning direction with one or more pressure chamber of another line head, and the nozzles that correspond to the pressure chambers located along the same line in the scanning direction are also located along a same line in the scanning direction; and

the actuators of the line heads cause an ink of a same type to be discharged, alternately by one shot or by a number of shots, from the nozzles that are located along the

same line in the scanning direction.

25. The ink jet head of claim 24, wherein:

the actuator of each line head includes a plurality of actuator blocks each having an area that is smaller than the pressure chamber block;

the actuator blocks of each line head are arranged in the head longitudinal direction so that adjacent ones of the actuator blocks are spaced apart from each other; and

the line heads are arranged so that the actuator block of each line head partially overlaps with the actuator block of another line head with respect to the head longitudinal direction.

26. The ink jet head of claim 20, wherein the actuator blocks are arranged in a staggered pattern.

27. The ink jet head of claim 24, wherein the actuator blocks are arranged in a staggered pattern.

28. The ink jet head of claim 20, wherein the actuator includes a conductive vibration plate that functions also as the second electrode, instead of including the second electrode and the vibration plate.

29. The ink jet head of claim 22, wherein the actuator includes a conductive vibration plate that functions also as the second electrode, instead of including the second electrode and the vibration plate.

30. The ink jet head of claim 24, wherein the actuator includes a conductive vibration plate that functions also as the second electrode, instead of including the second electrode and the vibration plate.

31. An ink jet head for discharging inks of different types, comprising a plurality of ink jet heads of claim 18 that are provided respectively for the different types of inks and are arranged in a scanning direction.

32. An ink jet head for discharging inks of different types, comprising a

plurality of ink jet heads of claim 19 that are provided respectively for the different types of inks and are arranged in a scanning direction.

33. An ink jet head for discharging inks of different types, comprising a plurality of ink jet heads of claim 20 that are provided respectively for the different types of inks and are arranged in a scanning direction.

34. An ink jet head for discharging inks of different types, comprising a plurality of ink jet heads of claim 22 that are provided respectively for the different types of inks and are arranged in a scanning direction.

35. An ink jet head for discharging inks of different types, comprising a plurality of ink jet heads of claim 24 that are provided respectively for the different types of inks and are arranged in a scanning direction.

36. A method for inspecting an actuator including a piezoelectric element, and a first electrode and a second electrode that are provided on opposite sides of the piezoelectric element, the method comprising:

a step of producing an actuator forming member in which the first electrode, the piezoelectric element and the second electrode are deposited in this order on a substrate, with a portion of the first electrode being exposed; and

an inspection step of inspecting a property of the piezoelectric element by contacting inspection probes to the exposed portion of the first electrode and the second electrode.

37. The method for inspecting an actuator of claim 36, wherein the step of producing an actuator forming member includes:

a step of depositing the first electrode on the substrate; and

a step of depositing the piezoelectric element and the second electrode on the first electrode while blocking a portion of the first electrode using a mask so that the portion becomes an exposed portion.

38. The method for inspecting an actuator of claim 36, wherein the step of producing an actuator forming member includes:

a step of depositing the first electrode, the piezoelectric element and the second electrode in this order on the substrate; and

a step of etching a portion of the second electrode and the piezoelectric element so that a portion of the first electrode becomes an exposed portion.

39. The method for inspecting an actuator of claim 36, wherein the step of producing an actuator forming member includes:

a step of depositing the first electrode and the piezoelectric element in this order on the substrate;

a step of depositing the second electrode on the piezoelectric element while blocking a portion of the piezoelectric element using a mask so that the portion of the piezoelectric element becomes an exposed portion; and

a step of etching the exposed portion of the piezoelectric element so that a portion of the first electrode becomes an exposed portion.

40. The method for inspecting an actuator of claim 36, wherein the inspection step includes a step of attaching a conductive paste material to one or both of the exposed portion of the first electrode and the second electrode, and contacting the inspection probes to the first electrode or the second electrode via the paste material.

41. The method for inspecting an actuator of claim 36, wherein the inspection step includes a step of measuring one or both of a relative dielectric constant and a dielectric loss of the piezoelectric element.

42. The method for inspecting an actuator of claim 36, wherein the inspection step includes a step of measuring a piezoelectric constant of the piezoelectric element.

43. A method for manufacturing an ink jet head, the ink jet head including:

a pressure chamber block including a common liquid chamber for storing an

ink, a plurality of pressure chambers communicated to the common liquid chamber, and a plurality of nozzles respectively communicated to the pressure chambers; and

a plurality of actuator blocks each including at least a piezoelectric element, and a first electrode and a second electrode for applying a voltage across the piezoelectric element, the plurality of actuator blocks being arranged on one surface of the pressure chamber block,

wherein before attaching the actuator blocks to the pressure chamber block, each of the actuator blocks is inspected by the inspection method of claim 36.

44. A method for manufacturing an ink jet head, comprising:

a step of producing a plurality of actuator forming members in each of which a first electrode, a piezoelectric element and a second electrode are deposited in this order on a substrate whose area is smaller than a pressure chamber plate, with a portion of the first electrode being exposed;

an inspection step of inspecting a property of each piezoelectric element by contacting inspection probes to the exposed portion of the first electrode and the second electrode of each actuator forming member;

a step of producing an actuator block on the substrate by depositing a vibration plate on the second electrode of each actuator forming member having undergone the inspection;

a step of attaching each actuator block, together with the substrate, on one surface of the pressure chamber plate so that more than one of the pressure chambers provided in the pressure chamber plate are covered by the vibration plate of the actuator block;

a step of removing each substrate;

a step of patterning the first electrode of each actuator block;

a step of attaching a channel plate on the other surface of the pressure chamber

plate, the channel plate including therein an ink channel for guiding an ink from the pressure chambers to nozzles and a common liquid chamber; and

attaching a nozzle plate including the nozzles therein to the channel plate.

45. A method for manufacturing an ink jet head, comprising:

5 a step of producing a plurality of actuator forming members in each of which a first electrode, a piezoelectric element and a second electrode are deposited in this order on a substrate whose area is smaller than a pressure chamber plate, with a portion of the first electrode being exposed;

10 an inspection step of inspecting a property of each piezoelectric element by contacting inspection probes to the exposed portion of the first electrode and the second electrode of each actuator forming member;

15 a step of attaching each actuator forming member having undergone the inspection on one surface of the pressure chamber plate so that more than one of the pressure chambers provided in the pressure chamber plate are covered by the second electrode of the actuator forming member;

a step of removing each substrate;

a step of patterning the first electrode of each actuator forming member;

20 a step of attaching a channel plate on the other surface of the pressure chamber plate, the channel plate including therein an ink channel for guiding an ink from the pressure chambers to nozzles and a common liquid chamber; and

attaching a nozzle plate including the nozzles therein to the channel plate.

46. An ink jet recording apparatus, comprising:

the ink jet head of claim 1; and

25 movement means for relatively moving the ink jet head and a recording medium with respect to each other in a scanning direction.

47. An ink jet recording apparatus, comprising:

the ink jet head of claim 11; and

movement means for relatively moving the ink jet head and a recording medium with respect to each other in a scanning direction.

48. An ink jet recording apparatus, comprising:

the ink jet head of claim 18; and

movement means for relatively moving the ink jet head and a recording medium with respect to each other in a scanning direction.

49. An ink jet recording apparatus, comprising:

the ink jet head of claim 19; and

movement means for relatively moving the ink jet head and a recording medium with respect to each other in a scanning direction.

50. An ink jet recording apparatus, comprising:

the ink jet head of claim 20; and

movement means for relatively moving the ink jet head and a recording medium with respect to each other in a scanning direction.

51. An ink jet recording apparatus, comprising:

the ink jet head of claim 22; and

movement means for relatively moving the ink jet head and a recording medium with respect to each other in a scanning direction.

52. An ink jet recording apparatus, comprising:

the ink jet head of claim 24; and

movement means for relatively moving the ink jet head and a recording medium with respect to each other in a scanning direction.

53. An ink jet recording apparatus, comprising:

an ink jet head manufactured by the method for manufacturing an ink jet head of claim 43; and

movement means for relatively moving the ink jet head and a recording medium with respect to each other.

54. An ink jet recording apparatus, comprising:

an ink jet head manufactured by the method for manufacturing an ink jet head
5 of claim 44; and

movement means for relatively moving the ink jet head and a recording medium with respect to each other.

55. An ink jet recording apparatus, comprising:

an ink jet head manufactured by the method for manufacturing an ink jet head
10 of claim 45; and

movement means for relatively moving the ink jet head and a recording medium with respect to each other.